Fire Prevention Guide

1 Fire precautions in town centre redevelopment

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This code of guidance has been prepared by a Home Office working party in consultation with the Joint Fire Prevention Committee of the Central Fire Brigades Advisory Councils for England and Wales and for Scotland.

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Contents

1 Introduction

Background and purpose of the code

1.1 This code of guidance on fire precautions in town centre development and redevelopment schemes was prepared by a working party appointed by the Joint Fire Prevention Committee of the Central Fire Brigades Advisory Councils for England and Wales and for Scotland. The working party comprised representatives of Government Departments and of the Fire Service; a list of its members is in Appendix A. The object of the working party was to lay down principles for the guidance of those concerned with fire prevention arrangements in town centre development and redevelopment schemes. Because schemes of this nature vary so greatly, it is not possible to make detailed recommendations which will be applicable in all circumstances. Where detailed recommendations can be made, they are included; in general, however, it will be necessary for the reader to interpret in individual situations the application of the main principles which this code of guidance attempts to set down.

1.2 The working party expressed the wish that the code should be used as guidance not only by the fire service, for whom it was primarily prepared, but also by local authorities, architects and others concerned with the design and development of these schemes. Compliance with the code cannot, of course, confer exemption from statutory requirements, but it is intended to indicate alternatives which might be acceptable where strict compliance with statutory requirements is impracticable, or incompatible with the general design concepts.

1.3 The code contains among its proposals recommendations which authorities may be expected to take account of when considering the application or relaxation or enforcement, as the case may be, of Building Regulations or statutes such as the Offices, Shops and Railway Premises Act 1963. Some of these recommendations are concerned with fundamental matters such as the design and construction of town centre development areas, and developers are therefore strongly recommended to discuss their ideas jointly with

the building authority, the fire authority and the Department of the Environment or the Scottish Development Department at a very early stage, in order to avoid the need for costly and perhaps inconvenient changes in their plans.

Scope of the guidance

1.4 The guidance is concerned primarily with that type of development and redevelopment scheme which can be termed a 'complex' and this term has been used commonly in the code for the sake of brevity. The term 'complex' may be taken to mean a multi-level, multi-occupancy development sometimes of considerable extent, perhaps including existing buildings or streets and incorporating some undivided areas of considerable extent. Normally the type of problem concerned will be confined to complexes consisting of more than one level and many types of occupany; a single storey pedestrian precinct will usually be capable of being dealt with according to conventional principles and is therefore not specifically dealt with in the code. However, some of the principles in the code may be useful where such a development is roofed over. It may be difficult, moreover, to identify a complex as a separate entity since developments will undoubtedly emerge in the future which will consist of a succession of limited complexes, without clearly defined boundaries.

1.5 Another point which should be borne in mind as regards the scope of the guidance is that it concerns itself primarily with the fire prevention aspects of complexes. While it is accepted that fire prevention and fire-fighting problems are frequently difficult to isolate from each other, and it is arguable that the greatest problems in town centre developments may be fire-fighting ones, the working party was limited by its terms of reference to dealing with fire prevention. Since, moreover, the fire-fighting problems of complexes arise out of the nature and disposition of the constituent parts of the complex, it appears to be a logical step to give attention to the principles which govern the arrangement and layout of complexes before turning attention to the fire-fighting problems which arise therefrom.

1.6 Finally, the working party has been concerned with rather different considerations and hazards than those of which the current Building Regulations in England and Wales and, to some extent, those applicable to Scotland, take account. The Building Regulations in England and Wales are directed to the health and safety of the public; those of Scotland are concerned with the safety, health and

convenience of people in a building and the safety of the public. The working party believed that its concern was more specific and that it should relate to the prevention of fire, restricting the spread of fire and means of escape from fire, and this approach has therefore been adopted.

2 Safeguards against fire spread

General principles

2.1 It is important to realise that, while it is necessary to restrict the spread of fire with the object of reducing the amount of damage, there are deeper and perhaps more important objectives. One of these is concerned with the fact that a fire which is allowed to spread beyond a certain extent in the early stages may well become uncontrollable: it may, in other words, present such difficulties because of its size that there is little prospect of its ever being brought under control. This could result in a conflagration in which the property loss was liable to be very serious indeed. Another objective of preventing or retarding fire spread relates to means of escape: although this is dealt with later in part 3 of the code, it may be said at this point that the basis of all provision for means of escape involves arranging the evacuation of a given part of a premises within a shorter period of time than that which smoke and fire will take to spread into that part of the premises and constitute a danger to the occupants. It follows, therefore, that the extent of the area through which a fire
relatively short space of time has a vital bearing on the possibilities of providing adequate means of escape.

2.2 It can be seen from these arguments that there is a relationship, however difficult it may be to express in quantitative terms, between the safety of a complex as a whole from the effects of fire, the danger of life which may result from fire
the extent of undivided areas within the complex. Indeed one of the principal reasons for the existence of the working party was to attempt to find a balance between, on the one hand, the needs of sound commercial practice, which requires the largest possible undivided spaces and, on the other, the need to avoid the possibility of an uncontrollable fire
arising in a complex.

2.3 A complex, if it were built entirely in accordance with Building Regulations, would incorporate reasonable safeguards against these dangers of fire spread and conflagration within the limits of ensuring

the safety of the public although, except in Scotland, the Regulations do not at present control the means of escape. Among the most important of these safeguards is compartmentation—the separation or division of a building into firetight cells in order to contain a fire within the compartment of origin. Relaxation of any particular regulation is considered where there are reasons to believe that this will involve no material risk, for example where other forms of safeguard are incorporated into the complex so as to achieve a standard of safety equal to that called for in the regulations. In particular cases, a more stringent standard may be recommended in this code and, in such a case, the reasons for the higher standard will be noted.

2.4 These safeguards are dealt with in detail in the following paragraphs. By way of introduction, it should be explained that they are of 3 kinds, viz:

a. those structural features which are applicable to the development as a whole, and

b. those constituting compartmentation and the sub-division of compartments, respectively. By the former is meant the creation, by means of compartment walls and floors in accordance with the regulations, of separate 'cells', each capable of containing a fire for a specified time. By 'sub-division' is meant an arrangement of interior walls, partitions, doors, etc, within a compartment so as to retard growth of fire within the compartment, and

c. except as provided in paragraph 2.7 complete sprinkler protection throughout the complex.

Structural features of the complex as a whole

2.5 The following should be incorporated into complexes of the type envisaged in paragraph 1.4 above:

a. **Non-combustible construction**

All structural elements of the complex and non-loadbearing walls around shops should be built of steel encased in concrete, reinforced concrete, masonry or brickwork (as appropriate).

b. **Fire resistance**

i. The structural elements and walls referred to in the previous paragraphs should have fire resistance normally of 2 hours but in certain circumstances up to 4 hours. In general, the higher fire resistance within this range would only be necessary for extensive storage compartments, for basements or for situations in which basement conditions are approximated. In

some purpose groups (in Scotland, occupancy groups) of low fire load it may be possible to reduce the fire resistance requirement to below 2 hours, though never below one. (See sub-paragraph iii. below.) In achieving this fire resistance, it is recommended that hollow coverings or casings in the form of a membrane should not be used to increase the fire resistance of structural elements which do not inherently possess the required fire resistance. It is considered that the risk of mechanical damage makes it desirable that fire-resisting construction be solid throughout. (This should not, however, prevent the use of hollow blocks or of solid bricks or blocks with a cavity between the brick or blockwork and the structural member.) It is also recommended that suspended ceilings which are intended to contribute to the fire resistance of a compartment floor above should not be included in the design of a complex.

ii. The fire resistance of any element of structure should not be less than that required for any element which it supports.

iii. The implications have been considered of providing a lower fire resistance in one part of a complex which may be expected to have a lower fire load than the remainder, subject to its being separated from the rest of the complex by compartment walls and floors and that the principles of sub-paragraph ii. above are met. While there might be dangers in this procedure if, at some later date, a change of occupancy group or purpose group of that part of the complex took place, and involved the use of that part for a higher fire load, this danger is not considered to be severe and may be disregarded. However, it it is important that information as to the purpose group or the occupancy group of all areas of the complex should be available at the planning stage; when this information is not available, the fire resistance should not be reduced below 2 hours.

c. **Boundary separation**

At the outer boundaries of the complex itself there should be either a separating wall or sufficient separating space between the complex and neighbouring property to ensure that fire spread cannot occur in either direction. Compliance with the appropriate regulations will ensure that adequate separation exists.

d. **Even distribution of fire risk and load**

It is desirable that compartments within a complex should show a general consistency of fire risk and fire load throughout the compartment. If any area contains an abnormally high risk or fire

load, a separate compartment should be created for this area, which should be fully compartmented (by compartment walls and/or floors) from the remainder of the complex. By 'abnormally' is meant a degree of fire risk or fire load markedly above the average of the remainder of the complex.

e. **Full horizontal compartmentation**

It is preferable that floors in a complex should be constructed as compartment floors. Where this is impracticable, some compensatory provision should be included to preserve the effect of compartmentation.

f. **Compartmentation of different purpose groups**

Parts of a complex which fall into different purpose groups should be fully compartmented one from the other. Moreover, where large units of purpose groups other than shops are to be placed on the same storey of a complex, they also should be fully compartmented: for example, if it is proposed to place a theatre and a cinema and/or some similar unit such as a bowling alley on the same storey of a complex there should be full compartmentation between each.

Compartmentation of shopping areas

2.6 a. **The effect**

The Building Regulations provide that, where sprinklers are installed, compartment sizes in shops at least may be larger, but still not infinitely large. The assumption behind this provision has firm origins in past history. The working party examined it carefully and, while they found it somewhat confusing, they were reluctant to attempt to put forward any alternative theory. The difficulty lies in the fact that, if a sprinkler system functions as it is intended, any fire originating in the sprinklered compartment should, theoretically, be controlled. This being so, it can be argued, the size of the sprinklered compartment could safely be infinite. However, there are certain factors which can, exceptionally, operate to interfere with the successful control of fire by a sprinkler system: one of them is a failure of the system to operate at all, and another is a failure of the sprinkler water to reach the fire effectively because of obstructions of one kind or another. These factors result in a diminished certainty of control by the sprinkler system, but to attach a quantitative value of this reduction of certainty is clearly impossible. The best compromise that has been suggested is that a sprinklered compartment is at least

twice as safe as an unsprinklered one of the same size, and to adjust requirements accordingly. Whatever may be the shortcoming of this viewpoint, it has been accepted for purposes of this code of guidance.

b. **Compartment size in sprinklered parts of complexes**

i. The current Building Regulations in England and Wales and in Seotland permit shop compartments to measure 14 000 m^3 if sprinklers are fitted. It follows that in a single shop, no part of the floor area should exceed approximately 3 700 m^2 (regarded in this context as equivalent to 14 000 m^3) and a compartment of this size should be fully compartmented from any other part of the shop. As for areas which consist of more than one shop (which we regard as being 'sub divided') no restriction on the total area is considered necessary if the following rules are adopted:

1. Not less than 60 per cent of the total area (excluding shops fully compartmented as in the previous paragraph) should consist of units (ie separate shops) not exceeding 280 m^2, each of which is enclosed as described in sub-paragraph 2 below or of the associated closed malls or open pedestrian ways.
2. The small shops referred to above should be enclosed on 3 sides by walls having fire resistance equal to the full eompartmentation referred to earlier as applicable to the 3 700 m^2 area. The frontage on to a covered mall or open pedestrian footpath will constitute the fourth side and shops on a corner site will not require a third enclosing wall.
3. The remaining area may consist of shops larger than 280 m^2 but smaller than 2 800 m^2 subject to the provisions in sub-paragraphs ii. and iii. below.

ii. A particular danger of extensive fire spread arises when large undivided units of area are placed opposite to one another, for instance with any part of their open sides facing across a mall or pedestrian footpath. It is considered unsafe for areas exceeding 2 000 m^2 to face one another in this way, unless both frontages are protected by automatically operated steel shutters giving at least one hour's fire resistance, or by 'back-up' walls, ie compartment walls of the same fire resistance behind the shop window display areas. Steel shutters should not be permitted to interfere with the means of escape. (See paragraph 2.11.)

iii. Similarly, if areas of this size adjoin one another with their open sides in the same plane, there is a risk of fire spreading from one large space to the next round the intervening wall. Such areas (ie those exceeding 2 000 m^2) should be protected by back-up walls behind the shop windows for a distance of at least 3 m on both sides of the intervening wall or be separated from each other by at least one small shopping unit not more than 280 m^2 in area.

c. Sprinklers should extend throughout an occupancy group.

Sprinkler protection

2.7 As has been indicated, the foregoing recommendations are made on the basis that sprinkler protection will be provided throughout the complex in general. Exceptions to this should not be made in shopping areas, but the general rule does not preclude the omission of sprinklers in certain circumstances, as follows:

a. where, in a compartment or space completely separated from its surroundings, some form of extinguishing system other than sprinklers is more appropriate, viz: a computer room, transformer chambers;

b. Where in a separate compartment as above an automatic detection system is more appropriate than an extinguishing system, viz: a public museum or a picture gallery;

c. where, exceptionally, a compartment is again fully separated and does not, because of its nature, merit such protection, viz: a car parking area with substantially open sides giving a high degree of continuous ventilation.

d. where a small complex which aggregates not more than 2 800 m^2 consists of not fewer than 5 shops.

Other factors to be considered

2.8 The foregoing are the general principles which are recommended for determining the sizes and arrangements of the various units which may be incorporated in the shopping area of a complex. Certain other features of such areas are dealt with in the following paragraphs.

Smoke venting

2.9 It will be clear that everything that has been said in the foregoing paragraphs about the risk of fire spread within a storey of a complex is much affected by the provision that can be made for the removal of the products of fire in the form of hot gas and smoke. It must be

accepted that the recommendations are conditional upon adequate provision of this kind being made; the amount of this provision, and the means by which it may be made are considered in part 7 of this code.

The effect of mall width

2.10 In considering a plan of a shopping area in a complex, it is obvious that there will be many occasions when shop units face each other across a pedestrian mall or footpath. Preceding paragraphs have pointed to some of the ways in which the risk of fire spread should be reduced in the circumstances, but it remains true that, particularly as regards the smaller areas, these will present a risk of early fire spread from the unit on one side of a mall to that facing it on the other side. This risk is much affected by the width of the mall, and this, in turn, will be affected by whether the mall is open to the air or roofed over. The danger of rapid fire spread across a covered mall is greater than is the case with an open mall, and of course the material effect upon means of escape is more serious in the case of the covered mall because of the tendency of the roof to cause hot gas and smoke to collect. It is therefore recommended that, without prejudice to any effect that means of escape requirements may have upon the width of malls (see paragraph 3.15), covered malls should not in normal circumstances afford a width of less than 6 m from shop window to shop window and that open malls should not afford a width of less than 5 m between shop fronts.

Fire-resisting shutters

2.11 Reference was made in paragraph 2.6b.ii. above to a condition in which 2 large shopping areas faced each other across a mall, and in which it was recommended that automatically operated fire-resisting shutters be provided across shop fronts as a means of avoiding the risk of fire spread across the mall. For the purpose of the Building Regulations, fire-resisting shutters constitute full compartmentation, ie they have the same value for purposes of compartmentation as a fire-resisting wall. Attention is drawn, however, to the fact that fire-resisting shutters have only been tested under BS 476 'Fire tests on building materials and structures' up to certain dimensions; in excess of a certain width or height for example, it is not possible to be certain that such a shutter will behave precisely in accordance with the tested sample. In addition, of course, single shutters do not provide insulation against the transmission of heat as a wall does. It is therefore recommended that shutters should not exceed 13m^2 in

area, nor more than 4m in any direction. Double shutters are recommended to ensure adequate insulation where compartmentation is required. Sensing devices should be placed both inside and outside every shutter position. From shops which are provided with shutters there must be alternative escape routes.

Fire-resisting glazing

2.12 In the circumstances described in paragraph 2.11 above, the question may arise of the effectiveness, for fire separation purposes, of fire-resisting glazing. It is possible, of course, for glazing, when installed in suitable frames, to provide fire resistance of up to one hour; however, this will have shortcomings as regards fire separation in 2 ways. Firstly, while fire-resisting glazing will remain in position and will resist penetration for the specified time, it nevertheless permits the passage of radiated heat and can thus lead to fire developing on the other side of the glazing under certain circumstances. Secondly, and for the same reason, it can present some danger to life when it acts as the separation between a fire and persons making their escape. For both these reasons, some limitations need to be imposed on the use of fire-resisting glazing in complexes as elsewhere, and for details of these limitations the reader is referred to British Standard Code of Practice No 152: 1966 'Glazing and fixing of glass for buildings'. Glazing is not permitted in compartment walls.

The value of drenchers

2.13 The use of drenchers has been considered as a means of providing compartmentation when shop frontages in a complex face each other. While not denying the value that drenchers may have in appropriate circumstances, it is not considered that they are suitable for providing the kind of protection called for between shopping areas in a complex. The principal reason for this is that a drencher system is essentially a means of keeping wet (and therefore cool) a vertical surface which is exposed to heat radiation. Many shop frontages in complexes have no shop windows, and a drencher system would not therefore be valid. Even when glass windows exist, reliance cannot be placed on a drencher system to keep these intact in the face of radiated heat from opposing shop frontages only a few feet away.

Automatic fire detection systems

2.14 Reference was made in the preceding paragraphs to the reduction in risk which occurs in shopping areas when sprinklers are

fitted. The question will arise in many minds as to whether a comparable reduction in risk can occur if an automatic fire detection system is provided and is connected directly to a fire brigade terminal point or an approved signalling station. In certain circumstances these detection systems may have great value but at the same time their function is not comparable with that of a sprinkler system, since the controlling effect of the latter upon a fire is direct and automatic. The provision of a fire detection system, however valuable in itself, cannot therefore justify relaxations from established standards of compartment sizes, etc in the particular context of complexes. More detailed consideration is given to the question of automatic fire detection in later paragraphs of this code.

Trade refuse

2.15 Cases will occur, particularly in large multi-level complexes, where facilities for the collection and removal of trade refuse have to be provided in close proximity to the shops in the malls. An acceptable solution is to provide large removable containers at service road level and ducts or chutes from the upper levels which will deliver the refuse direct into the containers. If so, the whole system should be contained within a protected shaft with adequate smoke extraction arrangements at high level direct to open air. Fire suppression systems should be extended to cover such shafts.

Unified ownership

2.16 The effectiveness of the measures outlined in these paragraphs for controlling the spread of fire in a complex is liable to be affected by the degree to which unified ownership applies in a complex. Many of these measures require inspection, maintenance and the co-operation of occupiers to ensure that they remain effective, and this in turn requires control and authority to be exercised from a single responsible body. This may well apply equally or more strongly to measures dealt with in other aspects of this guidance. The basis of control over the sizes and disposition of spaces etc which has been put forward should therefore be used only in cases where, due to unified ownership or other circumstance, a firm degree of discipline can be expected throughout the complex as regards fire precautions generally.

3 Means of escape from fire

Introduction

3.1 As was pointed out in paragraph 2.1 above, the basis for all provision for means of escape involves arranging the evacuation of a given part of a premises within a shorter period of time than that which smoke and fire will take to spread into that part of the premises and constitute a danger to the occupants. Three elements are thus needed to secure the safety of the occupants, viz design features in the premises to retard the spread of smoke and fire; a warning system; and adequate physical means of egress from the premises to match the number and physical ability of the occupants. The first of these 3 elements was dealt with in part 2, the second is dealt with in part 4 of the code and the third is considered in the following paragraphs.

General principle

3.2 The basic principle to be observed in providing means of escape from any building is that persons should be able to turn their backs on any fire or smoke which may be present in any compartment or section of a building and reach a place of safety by their own unaided efforts without being affected. This may be applied to complexes by the provision of adequate well-placed exits from floor areas and if necessary sufficient well-sited protected staircases within each occupancy unit; of pedestrian walkways or malls of sufficient width and height to afford safe, comfortable transit through the complex away from the affected area; and of facilities such as ramps, staircases, or other means, to enable persons to descend or ascend, if necessary from walkways or malls, to a different level.

Place of safety

3.3 Reference was made above to a 'place of safety'. This is the accepted phrase used, in connection with means of escape from single buildings, to denote the destination towards which the escape routes from a particular building are directed. Once that point is reached, the safety of the occupants is no longer deemed to be the

responsibility of those concerned with the building from which escape has been made. For this reason, a place of safety in the context of single buildings is normally a public street or open space.

3.4 In a complex, this concept must be differently regarded. In this case, the whole complex corresponds to the building, and the responsibility of the planners of means of escape continues, theoretically at least, until the boundaries of the complex are reached. Escape routes must be planned to allow continuous safe movement away from the affected area for an unspecified distance, so that people may ultimately be free of all danger from fire. In practice, the occupants of the complex will only need to move sufficiently far from the locality of the fire to ensure their comfort and safety, and how far this is, will either be self-evident at the time of an incident or be the subject of announcements at the time by responsible officials. For this reason among others some form of public address system may well be desirable, but more is said on this subject in part 4 of the code.

Escape from individual occupancies

3.5 In Scotland, means of escape are prescribed by the Building Standards (Scotland) (Consolidation) Regulations 1971 and escape routes or exits terminate at a 'place of safety' which is defined as either an unenclosed space in the open air at ground level or an enclosed space in the open air at ground level which has a means of access to such an unenclosed space by means of an exit or exits having a width or aggregate width not less than the width or aggregate width of the exits leading from the building to the enclosed space. In England and Wales however the majority of occupancies within a town centre development will fall within the uses set out in British Standard Code of Practice CP 3: Chapter IV: Part 2 (1968) 'Shops and Departmental Stores' and Part 3 (1968) 'Office Buildings', and it is recommended that these 2 documents should be consulted for details of planning and design of escape routes within these types of occupancy; similarly, Part 1 'Flats and Maisonnettes (in blocks over two storeys)' should be consulted where this is appropriate all these documents, escape is divided into 3 stages, the last of which always terminates at the final exit point from the building. The recommendations on means of escape in this code may be taken as applying from that point onwards, with only the following proviso.

3.6 In planning escape routes from single buildings, it is normally necessary to provide alternative routes in case one route is by the fire or its effects, but there is no objection to these routes,

although separate, terminating at adjacent points although not at the same final exit. For instance, 2 routes may debouch from the building through adjacent doors into the same street. In a complex, however, this area is liable to be enclosed by a roof or closely confined between neighbouring structures, and could thus be an unsafe area. It is important therefore in a complex that alternative escape routes should discharge occupants at points in malls, walkways or concourses distant from each other: such points should be separated from each other by a physical barrier capable of holding back heat and smoke. A case in point is where 2 alternative final exits from one occupancy are situated on different compartment floors; in this case, if one final exit is affected by fire, the other will be a safe area because of the intervening compartment floor. This arrangement has the additional benefit of allowing one route for access by firemen while the other is being used for the escape of occupants.

3.7 Additionally, as will be seen later from part 7 of this code the amount of smoke likely to be produced from a fire in a small shop in a covered shopping mall is so great as to put at risk those people who would be in other shops facing the same mall. Alternative means of escape should, therefore, always be provided from these shops, either at different levels, or at the same level but leading to different and separated places of safety, notwithstanding that alternative means of escape may not be required in the Regulations or the Parts of the Code of Practice referred to in paragraph 3.5.

Factors to be taken into account

3.8 The nature of each occupancy, the number of occupants—both staff and public, the number of people in the malls, the time allowed for evacuation of a compartment, an occupancy or part of an occupancy, the speed of travel on escape routes and therefore the maximum permissible travel distance, will all have a bearing on the means of escape to be provided within the complex.

Escape routes after stage 3

3.9 Subject to the proviso mentioned in paragraph 3.6 above, it will be reasonable for the normal means of access within the complex to constitute the means of escape from the final exit of individual occupancies providing also that the following conditions are complied with:—

Alternative routes

3.10 It should be possible, once outside the occupancy, to proceed in different
affected by the fire or smoke. Exceptions to this are:

a. where the route in question leads directly away from, and not parallel with, the frontage of the occupancy from which escape is being made;
b. where the final exit gives directly on to an open space of at least 60 m in its smaller dimension, which thus affords a route free of all hazard, such as a relatively unobstructed concourse, patio or plaza (provided that in the case of an enclosed concourse escape is possible in another direction); and
c. where, exceptionally, no alternative route is possible and a 'dead-end' condition exists. This will be compensated for when considering restrictions on the distance to be travelled (paragraph 3.11 below). But shops in 'dead-ends' should always have alternative means of escape.

Restrictions on distance

3.11 When persons are escaping from a final exit or exits along a mall, it may not be safe if they remain on that route in case they are overtaken by smoke or heat from the fire from which they are escaping. The distance along such a route for which it will be safe for them to travel will depend principally on whether the route is open to the air or roofed over and whether the route in question is a dead end or not, as described in paragraph 3.10 above. It is recommended that safe distances be determined as follows:

a. where there are routes open to the air and leading in alternative directions or leading away from an exit or giving on to an open concourse as described in paragraph 3.10 above ..... no limit;
b. where the route is open to the air but a dead end ..... maximum 25 m;
c. where the route is as described in a. above but is covered by a roof or ceiling ..... maximum 45 m;
d. dead-end conditions should not be created in covered or roofed-over exit routes;
e. In open malls, 'dead ends' without alternative exits should not be created where the length of a mall exceeds 4 times its width;
f. criteria for determining what constitutes an open route as opposed to a covered one will be dealt with later.

These distances are to be measured along a main acc
as a mall, walkway or concourse, without passing through any

occupancy, and are the maximum distances which may lie between the exit from the occupancy being considered and the open air at the boundary of the complex or a fire-resisting self-closing door leading either into another escape route or into a staircase enclosure from which another main access route can be reached at another level, again without passing through any occupancy.

Distance between exits

3.12 It is recommended that exits from closed malls affording main routes of escape (ie the exits just referred to in paragraph 3.11) should be placed at intervals along those routes of not more than 90 m. No restriction is necessary on the distance between exits from open malls.

Exit capacity

3.13 There should be sufficient exits of adequate width at intervals of 90 m (see above) from every mall or walkway to permit the full numbers of escaping persons to leave the mall without undue delay. In calculating these numbers the basic figure to be considered is the number of persons for whom exit capacity is needed in the occupancy exit doors leading on to the mall. To this figure will be added a figure to allow for persons who may be in the mall already which should be calculated on the basis of one person to every 0·75 m^2.

3.14 Each exit door or group of exit doors leading out of the mall should have a capacity of the number of persons (calculated as above) who have been provided for in the occupancy exits lying within 45 m of the exit or group of exits in any direction.

Width of malls

3.15 Whether a mall which acts as a main escape route is open or roofed over its minimum width at any point should never be less than the total width required in the exit doorways from the section of the mall concerned. If doors are placed across a mall used as a main escape route, their aggregate width should not be substantially less than that of the mall itself.

Later stages of escape routes

3.16 As was explained earlier, escape routes must continue, with adequate capacity, until the limits of the complex are reached. A main mall or walkway may lead straight to such a point within the recommended distance; if it does not, it will be necessary (as men-

tioned in paragraph 3.11 above) to provide, within that distance, an opening with a door leading either into a staircase enclosure and then into another main access route or directly into the latter. Malls or walkways can constitute these latter routes, provided they have the width recommended in paragraph 3.15 for main escape routes; additionally the stairways and doors into and out of them should have sufficient width to accommodate those people escaping from occupancies along the malls in addition to persons normally to be expected in the malls themselves. If, however, a mall or walkway which might be used in the later stages by people escaping from the centre of a complex does not itself serve as a main escape route from occupancies adjacent to it, there need be no restriction on the distance to be travelled in it.

Service roads and vehicular roadways

3.17 It is desirable to avoid the use of the service roads of a complex as escape routes from other parts of the complex, but if this is necessary in any particular case, pavements, or areas designated for pedestrians and segregated from the vehicle roadway, should be provided to a continuous width of not less than 2 m. If a covered service road is used for escape purposes in this way, the provision of adequate ventilation is of particular importance. (See part 7.)

Covered and open escape routes

3.18 It will sometimes be difficult to determine whether an escape route is covered or open; this is necessary to determine its correct width, but doubt may exist where, for instance, a mall is traversed by a wide bridge and therefore covered for part of its length. Similarly, walkways at an upper level may be provided along an open mall and tend to produce conditions in it as if the mall were covered.

3.19 A mall or walkway used for escape purposes should be regarded in plan, with the floors and/or bridges or gallery walkways above it superimposed upon it. If, then, in any 90 m length of the mall between exit doors, 25% or more of the area of the mall is found to be obscured, the mall should be considered as a covered route. If the percentage is less than this figure, it may be deemed to be an open mall. However, if the opening in a partly covered mall is a slot (formed for example by projecting continuous canopies) the mall may be considered 'open' unless it is more than 50% covered. Any part of a mall covered by a bridge or roof for more than 15 m of the length of the mall should be treated as a covered mall.

Escape from places of entertainment

3.20 In some of the larger complexes or developments it will be usual to find places of entertainment such as cinemas or dance halls, concert halls or assembly halls, together with hotels and blocks of residential accommodation. Each one of these should have its internal escape arrangements set out in accordance with accepted principles, but it should be ensured that the alternative exits from places of entertainment (ie the final exit of those routes which do not lead back by the same route as is taken to enter the premises) do not debouch into the same mall as that in which the main exits are situated. Ideally, they could be taken to a different storey from the main exits, so that there will be a compartment floor between the two.

Emergency lighting

3.21 In parts of precincts which normally require artificial illumination it is essential that there should be a system of emergency lighting which will come into operation automatically in the event of a failure of the normal lighting from whatever cause. The standard of emergency lighting necessary will depend very much upon the individual circumstances.

4 Fire warning systems and public control

General

4.1 The provision of a suitable warning in the event of a fire is an essential element in the safety of the occupants within a town centre development, and is closely tied to the means of escape arrangements. Building complexes of this type will comprise a number of separate compartments of varying occupancies such as shops, offices, entertainment centres, residential flats etc. In an emergency the occupants of these different premises will discharge into open malls, concourses and walkways, or, in the case of the larger complexes into internal covered malls and walkways.

4.2 Where open malls and concourses are available the problem of evacuation on the sounding of a fire alarm may well be similar to that encountered in the normal urban area where escape is into an open road or street. In the larger building complexes, however, malls, walkways and even concourses are often roofed over, extending some distance within the heart of the complex, and having in some cases other occupancies above them.

4.3 The considerable quantities of smoke and hot gases which can be evolved in a fire would in all probability discharge into a mall or concourse. If this were an open area there would be little hazard to means of escape, but on the other hand a covered mall may rapidly become sufficiently obstructed by smoke and heat to render means of escape along it impossible. Under these circumstances it becomes imperative that the occupants of other premises along the covered mall should be forewarned that evacuation may be necessary.

Warning systems

4.4 It is not intended to detail the various types and methods of raising the alarm. This is amply dealt with, in general, in British Standard Code of Practice CP 1019: 1972 'The installation and servicing of electric fire alarm systems' for the majority of occupancies found in a complex, and more specifically (in respect of particular occupancies) in the following:

a. British Standard Code of Practice CP 3: Chapter IV: Part 2 (1968) 'Shops and Departmental Stores'.
b. British Standard Code of Practice CP 3: Chapter IV: Part 3 (1968) 'Office Buildings'.
c. Department of Employment Booklet 'Fire Fighting Equipment, Fire Alarms and Fire Drills in Offices and Shops—SHW5'.

This guidance however, is concerned here with the fire warning systems in complexes and it might, therefore, be useful to outline the established principles of the single and two-stage alarms procedure.

4.5 The operation of a single-stage alarm is the signal for the complete evacuation of the premises concerned. No other decision is involved: all the occupants, both staff and public, are immediately aware of the alarm and the staff will assist in the evacuation without delay.

4.6 Where large premises which are divded into separate sections or occupancies are concerned, it may not be necessary to evacuate the whole of the premises on an initial alarm of fire in one occupancy or section of an occupancy. The two-stage system provides for an evacuation signal (usually continuous) to be given immediately in the affected section of the premises while an alert (usually intermittent) is sounded at the same time in adjoining section(s). This latter signal notifies the staff in those other sections that an emergency is in progress in part of the premises but that an evacuation in their section is not immediately necessary. If and when the situation requires a general evacuation of the premises the second-stage alarm (signal for evacuation) is given and then both staff and public should leave the premises. This system may also be adapted for use in multi-storey buildings to signal the evacuation of part of the premises, while sounding an alert signal throughout the rest of the building.

Application to complexes

4.7 For a fire warning system to be effective in a complex it must not only raise the alarm within the occupancy in which the fire occurs, but also, alert at the same time other occupancies at risk and indicate that an emergency has arisen. Such a signal would also imply that evacuation may follow should the situation deteriorate. The question of whether to evacuate other occupancies or not depends very much on the nature of the escape routes available. As already stated, open malls and concourses do not present any great problem to the safe movement of people discharging on to them, but covered malls which may become affected by smoke and hot gases may create a hazardous

situation in which the occupants of adjacent occupancies may find their escape route via the mall unusable.

4.8 Provision for raising the alarm in complexes can be made under 2 headings:

a. **Escape on to open malls and concourses**

In the smaller type of town centre development where there is adequate means of escape from individual premises on to open areas and the occupancies are suitably compartmented from each other, it is not considered necessary to alert any occupancy other than that in which the fire occurs.

b. **Escape on to covered malls etc.**

Where main escape routes from occupancies are directly on to covered malls or walkways additional fire warning facilities are recommended in the form of a two-stage system in which the alert signal should be given in neighbouring occupancies on the operation of the signal to evacuate the affected occupancy. 'Neighbouring occupancies' should be taken to mean those which have exits giving on to the same mall as those of the affected occupancy and to which means of escape are common.

Escapes into 'dead ends'

4.9 Where occupancies open into an open mall, and escape along that mall is in one direction only, an evacuation signal should be given in all the occupancies opening into that mall or any connecting but not separated mall and sharing the same single escape route, on the operation of an evacuation signal in any of them.

Public address systems

4.10 The use of a public address system to control and give instructions in the event of an emergency is one which is particularly applicable to large building complexes. The discharge of large numbers of people from shops and offices etc on to already crowded malls and walkways under emergency conditions will present a considerable problem. The orderly movement of these people along the malls away from the fire towards places of safety may be particularly difficult where the malls are roofed over.

4.11 The probability of quantities of smoke issuing into the mall from the occupancy on fire and spreading in both directions along the mall will, of course, affect the behaviour of people on the mall. Crowd control will be an important factor, not only for ensuring

the safety of the public, but also in allowing the fire brigade to gain access along the mall to the fire.

4.12 It is desirable that there should be a form of public address system installed in the malls where these are roofed over. If it is to be effective it is essential that the control of this system be in the hands of a responsible person who is in a position to give the correct instructions according to circumstances. Pre-planning may well be the key to the communication difficulties inherent in such a procedure, and there may be merit, for the initial stages of an incident, in the use of pre-planned, taped instructions which could be broadcast through the system within the affected zone on the operation of an evacuation signal in any occupancy. This would depend to some extent on whether a comprehensive and reliable system of security personnel existed in the complex.

4.13 In some cases there might be a need to extend the public address facilities to public areas in separated buildings forming part of the complex. If, however, there was already communication between the central control point and parts of the separated buildings, there might be no need for a public address system.

Requirements under legislation

4.14 Large building complexes may contain a wide variety of occupancies, but the majority will consist of shops of all kinds, both large and small, and offices. These types of premises are subject to the provisions of the Offices, Shops and Railway Premises Act 1963, which include the provision of effective means of giving warning in case of fire in premises requiring certification.

4.15 Premises within the complex which are used for public entertainment, such as theatres, cinemas, dance halls etc, will be licensed for their use or may be subject to the provisions of the Fire Precautions Act 1971. In these cases the provision of a fire warning system may be included in the conditions of licence or in the fire certificate.

4.16 It will be appreciated from what is said above that the recommendations in this code as regards occupancies giving on to open malls involve no greater provision than that required by the relevant legislation. However, where closed malls are incorporated in a complex, the recommendations of this code of guidance cannot be met by relying on the legal obligations of individual occupiers. In these circumstances, it is perhaps for the developer to accept the responsibility of providing a comprehensive system.

5 Means of calling the fire brigade

General

5.1 There should be adequate means in complexes for the giving of an alarm of fire to the fire brigade.

5.2 Within any complex there will be private telephones from which calls to the emergency services can be made during normal trading hours. There will, however, be times during which the commercial sections of a complex will be closed and calls to any fire discovered by a passer-by will have to be made by means of public facilities. Public telephone call-boxes are only provided where there is a likelihood of them being viable financially and this may be unlikely within the confines of a complex.

Street fire alarm systems

5.3 Because of the problem of clearly defining a position within a complex, especially for a comparative stranger, it is advisable that any means of calling the fire brigade should be such that it will be possible to locate the origin of the call and also locate the position in which the fire is stated to have occurred. One way of achieving this is by some variant of the street fire alarm, with alarm points installed at strategic places; when these are operated, an alarm is given from a readily identifiable position. This would obviate the difficulties mentioned above and also that which arises in areas with many immigrants who have little or no knowledge of English or of means of describing their position.

5.4 One complex has already been equipped with a number of heads which resemble those on the former police pillar box. The act of opening the door of the box transmits a signal which identifies the box on a panel in the fire station and, by means of the speech arrangements, the brigade operator is able to try to get further details.

The 'ABC' system

5.5 Another system which uses the existing telephone network is that known as the 'Alarms by Carrier' or 'ABC' system. This system,

which accepts signals from automatic apparatus and transmits them to the appropriate emergency service, is self-monitoring and is electronically tested every 3 seconds. The Fire Offices' Committee has agreed in principle that if this system is provided by the Post Office, it may be used in conjunction with automatic fire alarm equipment and it may therefore be taken to be acceptable for local fire alarm purposes.

5.6 One use of this system which might be envisaged would comprise a number of call-points installed throughout a complex, each one having a distinctive code; on the operation of a head the alarm signal would be routed by Post Office equipment to the fire brigade terminal point where the signal would operate a buzzer and a lamp and produce a print-out of the code number identifying the point, a serial number and the time of receipt of the signal. By this means, the brigade would be able to pin-point the exact location of the alarm and, by means of prior information recorded in the control, be able to determine the means of approach to the site and the risk area.

5.7 The ABC system can also carry signals from any type of automatic fire alarm system, automatic sprinkler system, or, if desired, any manual alarm system within a building or shop unit. Identification is thereby assured.

6 First-aid fire-fighting equipment

General

6.1 The provision of suitable fire-fighting appliances for use by the occupants of a building complex is dealt with under 2 main headings:

a. within occupancies; and

b. in malls, walkways and other public thoroughfares.

Within occupancies

6.2 Most of the occupancies normally found within a complex fall within the bounds of the Offices, Shops and Railway Premises Act 1963, and will therefore be required to have 'appropriate means for fighting fire'.

6.3 Other occupancies such as theatres, cinemas and similar places of entertainment will be covered by conditions of licence which generally include requirements regarding fire-fighting equipment, or they may be specified in a fire certificate issued for any premises to which the Fire Precautions Act 1971 applies.

In malls and public thoroughfares

6.4 It is considered unnecessary and indeed inadvisable to provide, for the use of the public, fire-fighting equipment in malls and other public areas. However, in circumstances where a complex is manned and patrolled by a full-time, trained security force it may be advantageous for equipment such as hose reels to be provided at strategic points throughout the complex. Such equipment would be for the use of the security personnel before the arrival of the fire brigade.

6.5 It should be pointed out that where equipment of this kind is provided in the public parts of a complex careful supervision and maintenance will be necessary to prevent misuse and vandalism. It is essential that any fire-fighting apparatus be always in good working order and readily available for use.

Scale and type of equipment

6.6 This code of guidance does not contain any detailed recommendations regarding the number or type of fire appliances required within occupancies in a complex. The decision as to the requirements of each individual occupancy must depend on such factors as size, layout, combustibility of contents, abnormal fire risks and so on.

6.7 There are a number of publications to which reference should be made for guidance:

a. British Standard Code of Practice CP 3: Chapter IV: Part 2 (1968) 'Shops and Departmental Stores'.
b. British Standard Code of Practice CP 3: Chapter IV: Part 3 (1968) 'Office Buildings'.
c. British Standard Code of Practice CP 402: Part 3: 'Fire Fighting Installations and Equipment: Part 3: Portable fire extinguishers for Buildings and Plant'.
d. Department of Employment Booklet—SHW5 'Fire-fighting equipment, fire alarms and fire drills in Offices and Shops'.
e. 'Guides to the Fire Precautions Act 1971—No. 1 Hotels and Boarding Houses'.

7 The control of smoke and heat

Introduction

7.1 There can be little doubt that in any fire occurring within a complex there will be danger that smoke and heat will affect the vicinity of the fire rapidly and on a large scale. Experiments have been made by the Fire Research Station into the possible spread of smoke from a fire in a small open fronted shop along a 6 m wide, 3 m high mall. With a relatively small fire, such as might exist within the first few minutes from its inception, exits up to 70 m from the fire in both directions could be difficult to use because of smoke in $2\frac{1}{2}$ minutes. Should the fire flash over in the shop the mall could be heavily smoke logged for 200 m in both directions in $2\frac{1}{2}$ minutes from the time of flash-over.

7.2 This rapid spread of smoke can lead to 3 problems. Firstly, the spread of smoke and hot gases (which may be deficient in oxygen and contain toxic combustion products) can hinder escape and endanger the lives of occupants of the building. Secondly, these smoky gases can restrict and even prevent effective fire fighting by the fire brigade. Thirdly, the temperature of the hot gases may be so high as to assist the spread of fire. These problems arise with fires in many situations but are accentuated by the size and complexity of many town centre developments. It is for this reason that the code recommends the provision of alternative means of escape, where this can be provided on different levels of the complex and leading to separated areas. However, there will be enclosed spaces in the interior of the complex, far from the outside air, whence the only routes for smoke and hot gases may be through corridors, covered access roads, malls and staircases constituting the routes for access of people and goods. Day-to-day ventilation may be by forced draught systems which are inadequate to exhaust the large volumes of hot smoky gases produced by a fire. Without special provisions incorporated in the design such systems might spread these products of combustion to other parts of the complex.

7.3 It is true that this code makes recommendations for structural barriers to enclose areas of specified extent so that a fire will be loca-

lised within those boundaries: however, these boundaries will not, at the time when the occupants are making their escape, be a positive barrier to the travel of smoke and heat. It will be evident that the damage, and obstruction to fire fighting, may well reach an extent considerably greater than the extent of the fire itself. For these reasons, features should be incorporated in the design of a complex whereby smoke and heat from a fire can either be localised or safely released to the open air.

7.4 Current designs of complexes approach this problem in a variety of ways; some attempt is made in all of them to provide a means of releasing smoke into the open air. It is common, for instance, to see some provision of fire venting in shopping malls; this must be accepted as particularly important, since in many cases there will be no shop fronts, and members of the public in the shopping malls will in reality be in one common area which includes many shops, most of which have a relatively high fire load. Some notes will be provided in later paragraphs describing various methods being adopted or considered at the present time for treating this problem, but as with all ventilation systems which depend upon creating a movement of air by natural means, much depends on the random effects of wind turbulence and the profiles of buildings, and this is an area in which there is little information available at the present time.

7.5 In the storage areas used by shops, the difficulties of fire venting below upper deck level have appeared to be insoluble in terms of the methods suitable at the upper levels. Most designs resort to the provision of exhaust vents in the form of vertical ducts, and in these cases there is even more uncertainty as to whether they will be effective in moving the very large quantities of smoke and hot gases which may be evolved.

7.6 This is an unsatisfactory situation, which arises from the basic fact that a big proportion of most redevelopment complexes are akin to basement designs. It is difficult to avoid the conclusion that some serious fire fighting and possibly rescue problems are awaiting the fire service when more and more complexes are completed and brought into use. The main difficulty is that because of the unpredictability of wind effects, methods of estimating the efficiency of smoke venting from the lower levels of buildings have not yet been fully developed. This being so, it is difficult to point with sufficient urgency to the need for taking action to provide a cure, and it is equally difficult to balance the cost of taking such action against the risk of damage. These are areas of uncertainty.

Methods available

7.7 The following paragraphs contain brief notes of methods which have been considered for removing smoke and heat and limiting their travel within buildings. Consideration is given to their applicability to complexes together with an indication of the required capacities of the systems. There are considerable practical difficulties inherent in most of them and it must be emphasised that there is urgent need for final solutions to be developed, evaluated and put into practice as soon as possible.

7.8 An important consideration when determining the scale on which to provide fire ventilation in any building is the size of the fire that is to be assumed. If sprinklers are fitted and in operation, it is reasonable to assume that the fire will grow no larger than perhaps 3 m by 3 m. However, it would be a departure from accepted practice to presuppose that provision for means of escape in a complex could be based on sprinklers confining a fire: this would be unjustified if for no other reason than that not all enforcing authorities for means of escape are authorised to impose requirements for the maintenance of sprinkler systems. If such a system did fail to operate for any reason the whole basis of the means of escape provision would be undermined. In the following paragraphs, therefore, the assumption is not made that the fire will be controlled to any specific dimensions through the provision of sprinklers.

7.9 It is important to note that many of the ways which could be employed to exhaust smoke and hot gases can themselves give rise to exposure hazards. It is an axiom that the process of exhausting smoke and heat from a building only transfers it from one place to another, and is frequently capable of creating a fire risk at the point where it is discharged. This should be borne in mind in every instance where steps are taken for the removal of smoke and heat.

7.10 Because of the possible rapid spread of smoke and hot gases, systems designed to provide ventilation to facilitate escape must operate at an early stage in the fire, at least as soon as the first sprinklers open. They should be automatic and smoke detectors are the preferred means of initiation. Many fire brigades may prefer that systems designed to provide ventilation to facilitate fire fighting should be under their control. This may be important with natural ventilation systems, which are subject to wind effects, but it must be remembered that it is easier to prevent a space becoming smoke logged than to clear it once it has become so.

Limiting spread of smoke

7.11 One method of confining smoke and hot gases is by limiting their spread to a single room even though this room will become smoke logged. In theory it is possible to prevent smoke and hot gases flowing out of the room through doors and other openings by providing a pressure of air outside the room greater than the natural pressure of the hot gases trying to flow out. This may be achieved either by extracting hot gases from the room or by creating a higher air pressure outside the room (this latter is the principle employed in the 'pressurisation' of escape routes). In either case, unless the room has direct openings to outside, ducts must be provided to carry away the hot smoky gases; fresh air to replace them will be drawn in via escape routes. In practice the size of fan and associated ducts required will be unacceptably large unless the area of openings into the room is very limited, and this generally means that self-closing fire doors to the room or shop must be provided and closed. Moreover, if fans are to be used on the extract side of such a system, they will have to handle the products of combustion and thus must be capable of withstanding the effects of high temperatures. This is likely greatly to increase the cost of an installation.

Removal by natural ventilation

7.12 There is considerable experience in the use of natural ventilation through roof vents to confine hot gases and smoke to a layer beneath the ceiling, with clear air near the floor, if a fire occurs in a large single storey building. This method may be used in the upper floors of complexes, (or lower floors if shafts are used to convey the hot gases through the upper floors). The principle is that, in the absence of disturbance, smoke and hot gases will initially form a stratified layer beneath the ceiling, the air beneath being relatively clear. Ventilation systems should be designed to draw off these hot gases at a high level while disturbing the stratification as little as possible. This generally entails a number of small outlets rather than one large one and the avoidance of high velocities in both inlets and outlets. An equal volume of air is required to flow into the building to replace the smoke and hot gases. This must enter the compartment at a low level beneath the layer of hot smoky gases.

Miscellaneous points

7.13 Several points which scarcely arise with single storey buildings assume considerable importance in complexes. Firstly the effects of wind both on vents and fresh air inlets must be considered. The

presence of taller parts of the complex adjacent to vent outlets may result in down draughts in unfavourable wind conditions. These difficulties may be overcome in certain circumstances by the use of chimneys above the roof level or by aerodynamic design of vent outlets so that the wind produces a suction effect. Secondly the position of vents and shafts will frequently be dictated by the layout of higher levels of the complex. This may mean that they are remote from the situation where fires may occur so that the gases may have cooled before reaching the vents. An increase in area is required to compensate for this. Thirdly shafts should be provided with a degree of insulation which will ensure that the temperature of the shaft is maintained at least as high as that of the space being vented or there may be some difficulty in establishing an up-draught with a small but smoky fire.

7.14 In the light of the foregoing, 2 main alternatives present themselves as solutions to the problem: confining the smoke to the shop of origin so as to prevent it affecting the pedestrian mall on a large scale; and removing the smoke from the mall on the assumption that the former method is impracticable. In both methods the 2 alternatives of powered extract fans and natural ventilation must also be considered.

7.15 It is important that any forced draught system, and any natural ventilation system in so far as it is controllable, should be capable of being controlled by the fire service as soon as it is ready to begin fire-fighting operations. This should be achieved by suitably positioning and identifying switches and dampers.

Confinement of smoke to shop of origin

7.16 One effective way of preventing a shopping mall becoming smoke logged is to confine the smoke and hot gases to within the shop on fire. If the shop were fitted with self-closing fire doors the principles of paragraph 7.11 would apply and a relatively small powered extract system would suffice to ensure that smoke and hot gases did not penetrate to the mall. However, the practice of designing shops without shop fronts has become so prevalent and widespread that the existence of a shop front cannot always be assumed, and this would put a powered extract system beyond the bounds of practicability. It may, however, be practicable to use natural roof ventilation in, for instance, a single storey development or the top floor of a multi-storey one. This is analogous to the use of roof vents over the stage of a theatre.

7.17 In shops fronting on to a covered mall it should be possible to assume that a fire would, in the early stages at least, involve only a part of the floor area of the shop. The flow of hot gases into the mall at high level could in theory be prevented by a fascia combined with adequate ventilation and it is immaterial whether the shop is otherwise open fronted. The minimum required depth of fascia may tentatively be given as 1 m. If the fire is taken as having an area of 3 m × 3 m (and thus a perimeter of 12 m) and the ceiling height as 3·8 m the required ventilation rate may be calculated (on present evidence) as being 28·3 m^3/sec. This represents 5 air changes per hour in a shop with a floor area of 4 645 m^2. The number of air changes required per hour would be larger if the fire became larger, or if it were of the same size in a smaller shop, and the size of extract system required for even a small fire would be practicable only in the largest shops.

7.18 Natural ventilation for a fire with the same or a larger perimeter would require at least 10 m^2 of vents. If the outlets were some distance above ceiling level (ie via shafts) a lesser area of vents would suffice. With natural ventilation the space beneath the ceiling of a large shop should ideally be divided by screens of the same depth as the fascia into 'compartments' of preferably 930 m^2 maximum area, each containing sufficient ventilators to exhaust the hot gases from the 'design' fire. For each 12 m of perimeter of a fire 1 per cent of floor area is required; if the ceiling cannot be sub-divided the vent area should be increased.

7.19 It will be seen from the above that in practice the prospects of successfully confining smoke and hot gases to the shop of origin are not favourable. Better possibilities may be offered by the attempt to remove the smoke and heat from the mall, assuming that it will unavoidably find its way there.

Removal of smoke and heat from shopping malls

7.20 The presence of a layer of smoke and hot gases beneath the ceiling will inevitably cause apprehension to the occupants of the shopping centre even though the air below is clear. To minimise this apprehension and prevent the possibility of panic the bottom of the layer of hot smoky gases should be as high as possible above people's heads. There is probably a minimum depth for the layer of gases and this may be as much as one third of the ceiling height; certainly it is unlikely to be less than 1 m. If the shop or mall is 4 m high this means that the bottom of the layer of hot smoky gases will be only about

2·7 m from the floor. This is the absolute minimum height necessary with no factor of safety. Thus generally the ceiling should be much higher than 4 m. It is tentatively suggested that the smoke reservoir should be at least 1 m deep and preferably should have a depth equal to one third of the height of the ceiling above the floor.

7.21 The length of mall over which this layer extends should be restricted as far as possible by screens extending at least 1 m from the ceiling, at intervals tentatively suggested as not exceeding 60 m. This length of mall should be provided with sufficient ventilation to remove the smoke and hot gases produced by a fire in a shop. The area of natural venting required in the mall will be greater than in the shop on fire because the vents will be further from the fire and the gases passing through cooler; however, an aggregate cross sectional area of vents equal to 3 per cent of the floor areas of the mall, in the case of a 3·8 m high mall about 7·3 m wide, should be adequate for each 12 m of perimeter of fire in a small open fronted shop. (For a full description of automatic venting systems see Fire Note No 5 prepared by the Joint Fire Research Organisation and published by HM Stationery Office.)

7.22 When a covered mall extends through 2 or more storeys with walkways at upper levels it is necessary to ensure that the layer of smoke and hot gases is not so deep as to hinder escape from the upper walkways. If there is a fire on the lowest floor the gases will mix with the air in the mall so that the volume to be evacuated is several times greater than that considered in paragraph 7.19 and the area of vents will need to be correspondingly greater.

Removal of smoke and heat from lower levels

7.23 Most schemes, as at present designed, allow for only 2 ways whereby smoke can be exhausted, or can exhaust itself, from the lower levels of a complex. The first of these is the possibility (and it may be no more) that the smoke will disperse by way of the service roads to open air. The second is by the provision of vertical extract ducts terminating in the open air. The problems of the removal of smoke and hot gases from lower levels are theoretically no different from the problems of their removal from upper levels and the volumes of hot gases to be discharged are the same. Practical problems arise with natural ventilation because the hot gases need to be ducted through the intermediate floors although the cross sectional area of ducts required decreases as the vertical 'head' of gases in them increases.

7.24 The theoretically ideal scheme for a complex would provide ducts of generous cross section at frequent points at all levels, discharging from outlets in the open air above the higher deck level. Dampers, either operated by hand or by a system of detectors, would be provided at the tops of the ducts. Individual ducts would be needed to serve different levels. Where there was no prospect of effective chimney action at the top of these ducts, mechanical ventilation would be provided as a supplement. This is at present an unrealistic picture: efforts of this magnitude are not made in present day redevelopment schemes to deal with the problem. The problem has not yet demonstrated itself to its full potential: it may be necessary, when experience has been gained of the incidence and type of fire to be expected in complexes, to work more vigorously along these lines.

Recommendations

7.25 1. When the preliminary work of the Joint Fire Research Organisation on the control of smoke and heat in complexes is duly taken into account, it is considered that the recommendations for means of escape in part 3 of the Code are still valid and reasonable, providing that adequate ventilation is incorporated as specified below.

2. Ventilation openings with the object of releasing smoke and hot gases from pedestrian malls should be provided equal in total area to 3 per cent of the mall floor area, and this should be combined with screens fitted into the ceilings of the malls as described in paragraph 7.21. The venting system should be so designed that the wind is unlikely to have an effect on its operation (see paragraph 7.13).

3. In any design in which ventilation openings in pedestrian malls are not provided to this extent, compensatory means should exist for confining smoke and hot gases within the shop of origin. This may be achieved by methods described in paragraph 7.16.

4. Ventilation openings, associated with vertical extract ducts, should be provided from spaces in the lower levels of complexes to the same extent as has been recommended for pedestrian malls. If any such extract system is assisted by a reliable system of forced draught, the size of the ventilation openings may be reduced to provide an equivalent effect.

5. Experimental work on the control of smoke and gases in complexes is being pursued by the Fire Research Station, and designers should be prepared to modify their practices in the light of further information which the research work may bring to light.

8 The siting of fire stations

8.1 Redevelopment areas and complexes may affect the siting of fire stations in one or more of the ways described in the following paragraphs.

Restricted access for vehicles

8.2 The time taken to attend at a fire may be lengthened due to the impossibility, in many cases, of reaching the scene of the fire with a fire-fighting vehicle. If such a vehicle can proceed only to within a certain distance of a fire, the crew will have to proceed the remaining distance on foot, either on the level or between levels using stairs or lifts or both: equipment will, moreover, have to be transported in the same way. This will apply particularly in such parts of the complex as extensive shopping areas on floors above or below the level at which vehicle access is possible. This situation points to the conclusion that if attendance times are to be maintained, vehicle travel time must be reduced and hence that fire stations may need to be sited nearer development areas and complexes.

Circulatory and linear traffic schemes

8.3 In a large complex, lengthened attendance times may be expected if there is an arrangement of traffic routes involving longer travel than would normally be the case. Plans have been suggested for new towns in which main vehicle roads are confined to the perimeter of the whole development, and access to the interior by means of subsidiary vehicle roads would be sparse in the extreme; a situation could be envisaged in which a fire appliance needed to drive 5 miles round the perimeter road and half a mile on the subsidiary road to reach a point which was, in fact, only three-quarters of a mile from the fire station as the crow flies. Where an existing city includes a large development complex which has a linear development rather than a radial one, it may be found that access for vehicles across the development is forbidden, and any cross traffic is required to go round the development at one end or the other. This, may substantially increase the distance between a fire station upon one side of the complex and the other.

8.4 While schemes of this type may well affect decisions about the siting of fire stations, it is clearly desirable that the planning of a complex should be undertaken with the effect on fire brigade attendance times in mind. Minimal changes may then permit acceptable attendance times to be maintained without the need to resite fire stations nearer or possibly within a complex.

9 Identification of addresses

9.1 One of the problems associated with complexes and redevelopment areas is the absence of the conventional form of address for any premises or occupancy. By conventional address is meant the name or number of the premises, the name of the street in which it is situated, followed by the name of the district or locality.

9.2 It is reasonable to assume that other methods of identification will be employed for premises in complexes and these may include the following:

a. reference to named buildings or parts of buildings together with the floor of the building and a number for the premises on that floor;
b. reference to a zone of the complex perhaps with further letters or figures to signify particular premises within the zone;
c. reference to levels within the complex;
d. reference to pedestrian malls or walkways;
e. reference to access points into the complex, whether for pedestrians or for vehicles.

There is unlikely to be any consistency between complexes and this presents obvious difficulties in identifying the most suitable route and access to an incident for fire-fighting purposes, especially where reinforcing moves are involved.

9.3 There is obvious advantage if developers can be encouraged to use a system of nomenclature in which the address always causes some indication of the correct access point for emergency attendances. One simple way of achieving this in part is by the provision of a public alarm system such as is referred to in paragraph 5.3. In this case, the point of origin in a case is automatically indicated by virtue of the circuitry employed and it is comparatively easy for the fire brigade to associate an access point with each calling point of the alarm system. If the system is zoned, so that an indication of only the zone is received when a call is given, then attendance will be made to a specific access point for each zone.

9.4 Unfortunately, such an arrangement will only cover calls put through from call points on the alarm system, whereas fire calls from premises which are occupied at the time will in some cases be put through by exchange telephone. This is liable to result in a call being given to, for instance, 'British National Stores, Woking New Town', which gives no indication of the access point to be used.

9.5 In relation to small complexes or shopping centres it seems likely that this difficulty can be overcome within the framework of the card index systems at present used by brigades for conventional addresses, without the need for recommending special systems of nomenclature.

9.6 In larger complexes the difficulty will remain. Where a security staff is provided and fire calls are routed through a central control point in the complex (though this is not an arrangement recommended in part 5 of this Code), the security staff can add to a fire call the requisite indication of which access point is to be used by attending appliances. Where fire calls are made direct to the fire brigade from individual occupancies, it seems vitally necessary to arrange with developers or occupiers that telephones be fitted with cards or notices showing how the address should be given when making an emergency call. The address as given should always include a code name, letter or figure which can be linked with an access points.

9.7 In some cases it may be expedient to link with this the provision of directional signs (illuminated as necessary) at access points to guide appliances to the appropriate vertical access point (see paragraph 10.3) relating to the addresses or zones indicated by the code names, letters or figures referred to in paragraph 9.6 above.

9.8 There would be obvious advantages for the fire service and other emergency services if these arrangements could be uniform throughout all complexes. Whilst this is perhaps an unobtainable ideal, fire authorities are recommended to try to ensure at least that uniform arrangements exist in all complexes within their areas.

10 Access for fire appliances

10.1 The main point in question here is the distance which may lie between the location of an incident and the nearest point in the complex to which a conventional type of fire appliance can be driven. This distance may be either horizontal or vertical or a combination of both.

10.2 The point to which an appliance may be driven may be on the perimeter of the site where access is by means of public or service areas; the resulting distance to the incident may then be mainly horizontal along the pedestrian ways or elevated walkways.

10.3 In the case of those developments which cover a large area and which are of multi-storey construction, access for appliances within the boundaries of the site may well be limited to service roadways; these are provided primarily for the use of vehicles delivering goods to points from which they can readily be taken direct to the occupancies. These access roads may be at basement level but they may, because of road planning and varying ground levels round the development, be above surrounding ground level; in this case, access from the service roadway may be possible both downwards and upwards. Where this is so, it will be necessary for access to be provided for firemen to reach the upper and/or lower levels, and to take with them conveniently and quickly such items of equipment as they require for an immediate attack on the fire. This access should take the form of enclosed common staircases and/or lifts, the latter to be fitted with the necessary controls to enable firemen to take them over for use in an emergency. From the developer's point of view, if these means of access can be used for other purposes, eg day to day running of the site, means of escape requirements etc, it is likely that they will be the more readily provided. The positions for these points of vertical access would depend on the planning of the service roadway in conjunction with the layout of pedestrian ways or malls at the levels above or below, but such points should not be more than 45 m from the points at which conventional fire appliances would be

parked and not more than 90 m apart. These appliances would normally be those comprising the first attendance; any subsequent reinforcing appliances or those carrying special gear would, it is expected, be directed to a marshalling area (associated with a control point) clear of the service roadway from where they could be ordered in as necessary.

10.4 However, it may be that the means of fire fighting on the upper or lower levels would include fire mains (see paragraph 11.1); if these were dry and installed within the staircases or lift enclosures, the usual requirements of access for a pumping appliance to within 18 m of and in sight of the inlet to the main would apply. It is essential that some control should be exercised by the developers over the movement and parking of commercial vehicles on the service roads, so that emergency vehicles would not be obstructed should the necessity arise for them to gain access in an emergency.

10.5 It must be envisaged that the necessity will arise for the provision at podium level of some piece or pieces of fire-fighting equipment that will require the use of a lift car with a floor area larger than the usual 1·5 m^2 or with a carrying load more than the usual 544 kg. It will usually be possible to use a communal goods lift or one provided in one of the unaffected tenancies and from where, at the upper or lower level, the equipment can be manhandled along a level access to the incident.

10.6 Where developments extend over a large area it may be necessary to consider a requirement for pumping appliances and those appliances carrying portable ladders to be driven along predetermined and strengthened routes to a point near to an incident where the equipment will be close at hand. Such routes should be clearly indicated.

10.7 Consideration should also be given to whether access can be made available to upper levels or podium decks, by way of ramps where there may be access across the open or top deck to other structures within the complex. This suggestion may infer that there is a case for the use of a smaller, lighter fire appliance capable of carrying light equipment and a crew to pedestrian walkways and other levels of a complex. Whether this would provide a solution to problems of access would involve a comparison of the cost of providing decks and ramps capable of taking the weight of a specially designed appliance against the cost of a conventional deck and ramp. It may be found that a form of construction which gives structural

stability and the appropriate degree of fire resistance according to the purpose group or occupancy classification under the Building Regulations will also adequately support a lighter than normal fire appliance carrying the gear necessary to fight a medium sized fire at an upper or lower level. Any added cost of improving the weight carrying capacity of a structure will probably be found to be a very small proportion of the total cost of the structure.

10.8 A further point which may justify the provision of high-level access is the need to use it as a vantage point in order to fight fires in other buildings within the complex, where these buildings do not possess the internal rising mains and other features facilitating internal fire fighting. This is likely to arise when older buildings are incorporated within the area of a new development.

10.9 Consideration has been given to the problems the fire service would have to face in getting from the access point at service road level to the fire itself and paragraph 10.3 above suggests the provision of staircases and/or lifts at predetermined points. It is suggested that if access cannot be made available for vehicles to reach the upper or lower levels then goods lifts should be available, one every 180 m if up to 2 floors above have to be traversed or one every 90 m if more than 2 floors.

11 Water supplies

11.1 Some indication has been given in part 10 (access for fire appliances) of the handicaps which may be experienced by the fire service in fighting fires in complexes. These include the time taken in reaching the fire after leaving their appliances and the difficulty of co-ordination of effort when appliances are remote from the fire-ground. It is essential that these handicaps should not be increased by any failure to provide adequate quantities of water at suitable and easily accessible positions.

11.2 The needs of the situation can be expressed quite simply as follows:

a. It must be possible to get sufficient branches to work to cover any reasonable eventuality.
b. Each of these branches will need a foreseeable amount of water.
c. Branches must be supplied from a point which is not at such a distance from the branch itself as to be operationally unacceptable.
d. Branches are ineffective if the water does not reach them at sufficient pressure to provide good jets, having regard among other factors to the loss of pressure due to friction in hose lines and to pressure lost in overcoming height.
e. At no time during the course of a fire must conditions arise in which water supplies fail or cannot be maintained at an adequate level, whether by reason of the number of hydrants opened, the number of sprinkler heads operating or any other factor.

The first 2 of these needs can be specified in terms of the discharge capacity of the mains through a specified number of hydrants opened at the same time; the third in terms of the density at which hydrants are provided; the fourth in terms of the running water pressure available at a hydrant when that and other hydrants are opened at the same time, and/or of facilities for pumps to be got to work from hydrants; and the fifth in terms of supplementary or alternative mains supplies.

Hydrants in complexes with appliance access to perimeter only

11.3 Where a development is of limited area and has vehicle access only to the perimeter, there should be charged hydrants at vehicle access level on the perimeter at such intervals that no hydrant is more than 90 m from another. The flow from hydrants should be such that, when 4 of them are open at the same time, the total volume discharged is not less than 4 500 litres/min. The running pressure at the open hydrants should be such that, when 2 adjacent hydrants are open at the same time, each can supply a nominal $\frac{3}{4}$-in (9 mm) nozzle through one length of hose at a (running) nozzle pressure of 5 bars. If the complex has a level which is more than 18 m above ground level (or appliance access level), any rising mains should be provided with inlets immediately adjacent to each hydrant and outlets on each level. If the height exceeds 60 m, this should be a charged rising main. (See paragraph 11.8.)

11.4 In addition, arrangements should exist whereby the water undertaking can, at short notice, restore the conditions specified above in the event of failure or shortage of supply in the mains by diverting supplies from an alternative main. Where the water undertaking is unable to effect this diversion from an alternative main in the area, the nearest hydrant on the alternative main should be not more than 150 m from the perimeter of the complex at its nearest point.

Hydrants in complexes with appliance access at main upper deck level

11.5 It is recommended in these instances that hydrants be provided throughout the area of the main upper deck and on all other levels giving access to individual occupancies. No hydrant should be more than 90 m from another and the flow from each should be such as to conform with the recommendations of paragraphs 11.3 and 11.4 above.

Hydrants in complexes with appliance access at low level

11.6 In this situation it is desirable that charged hydrants as specified in earlier paragraphs should be provided at appliance access level, on all levels above or below this which give access to individual occupancies, and on the main upper deck level. The hydrants at appliance access level should preferably be situated immediately adjacent to staircases affording vertical access.

11.7 In complexes which have not more than 2 levels above appliance access level, it is for the fire authority to determine whether it would be satisfactory to forgo the provision of charged hydrants on the upper levels and recommend instead a dry rising main immediately adjacent to each hydrant on the appliance access level. This would require outlets on all upper levels giving access to individual occupancies and on main upper deck level. In deciding this the factors to be taken into account would include the layout of the complex, the nature of the fire and life risk at various levels and the height of buildings at main upper deck level.

Tall units within or on complexes

11.8 The provision of dry or wet rising mains within tall units forming part of a complex should follow the recommendations of the appropriate Part of British Standard Code of Practice No CP 3 Parts 1, 2 and 3.

Testing and maintenance

11.9 The importance of hydrants and rising mains being constantly available and in perfect working order should not need to be emphasised. To this end, they should be regularly inspected, tested and maintained. It is recommended that these devices be accepted by the authority responsible for the management of the complex as a whole.

12 Communications for fire service use

12.1 Effective communications are vital to successful fire fighting. The more widespread the fire operations, the more elaborate and yet smooth-working the communications require to be. The need for good communications is particularly great in complexes, when personal contact between fire brigade detachments and between them and the management of the complex is likely to be inherently difficult.

12.2 A survey of the needs of the fire service in this respect will be assisted by regarding their communications requirements as falling into 3 main categories, viz:

a. Operational communications between fire service units on the site;
b. Operational communications between fire service control points on the site and fire brigade headquarters;
c. Executive communications on the site enabling the fire service to obtain information from and give instructions to the management of the complex and to the public and to supplement a. and b.

For ease of reference these 3 needs will be referred to in the following paragraphs as mobile, headquarters and fixed communications, respectively.

Mobile communications

12.3 In normal circumstances, fire brigade units on the site of a complex will use personal radio sets for communicating with each other and with their own control points, until such time as some fixed form of communication has been established. (This is, of course, only necessary when fire-fighting operations are protracted.) Personal radio sets, which are extremely useful as an emergency means of communication because of their easy portability, have certain disadvantages: these include occasional poor reception due to local screening and limited battery life. It is therefore desirable

that mobile communications should be supplemented and later substituted if possible by using some form of fixed communications as described later.

Headquarters communications

12.4 Similarly, the fire service would use the mobile radio stations on its own appliances for communicating with brigade control in the early stages. Here again, however, it might be undesirable to rely entirely on this means throughout a protracted operation: there may be local difficulty in reception, as with personal sets, and there will also be difficulty and waste of time where the appliances have to be placed (because of limited access) remote from the seat of fire-fighting operations. The fire service will therefore need to place some reliance on the fixed communications provided in the complex as discussed below.

Fixed communications

12.5 Various methods of communication will be provided in every complex, and mention has already been made elsewhere in the code of the question of providing the means of calling the fire brigade to a fire. In that context the code pointed to the need, in the larger complexes at least, for a centralised and constantly manned control room which would act as a co-ordinating point for many forms of fixed communications. In the present context, it is right to place even greater emphasis on the value of such a provision, which would enable all emergency services, the fire service included, to establish fixed lines of communication through such a point as a supplement to or in substitution for their own pocket or portable or mobile radio stations. The following paragraphs contain notes on some of the forms of communication which might be embraced by the arrangement.

Emergency call points

12.6 If these are provided in the public parts of a complex, they should be equipped with telephone heads enabling firemen and other authorised persons to speak to the control room and/or to other call points.

Direct line to fire brigade headquarters

12.7 A control room, if connected by direct line to the fire brigade, will provide a permanent, direct speech link between fire service control points within the complex and the headquarters of the fire

brigade throughout fire-fighting operations. If a direct line is provided, it should be possible to link any telephone extension or call point via a switchboard in the complex control room, to the private wire to the brigade control room.

Extension telephones in occupancies

12.8 There may be telephone extensions within occupancies, connected to a private exchange. If this exchange is situated, as it should be, in the control room, the extension telephones will form an extremely useful fixed communications link with the centre and through it, with other localities where control points may be set up by emergency services. Extension telephones could also be used for external contacts, eg via the private wire to the fire brigade control.

Plug-in telephone circuits

12.9 Many developers have made arrangements with the managements of buildings for the provision of built-in telephone wires, into which the fire service can plug its own telephone instruments and obtain speech facilities. These are normally associated with the lifts provided for the use of firemen in high buildings, or with wet or dry rising mains systems. In a complex, if other fixed communications systems such as are described in paragraphs 12.6 and 12.8 above, are not available, this plug-in facility could with great advantage be extended so that connections could be made to the control room from any plug-in point. Points of this kind could be provided not only at lifts and rising mains but at hydrants and in stairways.

Other fixed systems

12.10 Other features which may be provided in complexes and which could be of value to the fire service or other emergency services in a communications sense, include the following; where appropriate, they should also terminate in a control room:

a. Public address equipment.
b. Closed circuit television monitors.
c. Indicator lights linked with fire or smoke detection systems.
d. Indicator lights linked with sprinkler systems.
e. Emergency telephones for the use of authorised persons in appropriate parts of the complex.

Route light systems should also be linked to the control.

Appendix

Working party on fire prevention aspects of town centre development and redevelopment schemes

List of members

Mr P S Wilson-Dickson OBE (Chairman)	*HM Inspector of Fire Services Home Office*
Mr G G Connell	*Fire Adviser HM Factory Inspectorate Department of Employment*
Mr A J Cotsell (superseded by Mr A G Hillier)	*Department of the Environment*
Mr A P Roach	
Mr J Jackson OBE	*HM Inspector of Fire Services Scottish Home and Health Department*
Mr W T Sutherland	*Scottish Development Department*
Mr G Langdon Thomas	*Fire Research Station*
Mr P L Hinkley	
Mr E A R Hibbitt MBE	*Director of Studies Fire Service Staff College*
Mr P Watters	*Chief Fire Officer Newcastle and Gateshead Joint Fire Service*
Mr G F Goodman MBE	lately *Senior Fire Prevention Officer Birmingham Fire and Ambulance Service*
Mr A H Forder	lately *Senior Fire Prevention Officer Wiltshire County Fire Service*
Mr G P J Cooper QFSM	*Firemaster Glasgow Fire Brigade*
Mr C H Gibbs (Joint Secretary)	*Assistant Inspector of Fire Services Home Office*
Mr P E Bolton (Joint Secretary)	*Home Office*

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